

NPOESS:

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This is the fifth in a series of articles on the National Polar-orbiting Operational Environmental Satellite System (NPOESS). As a critical component of an Integrated Earth Observation System, NPOESS will continuously monitor and observe land, sea, and air to help "take the pulse of Planet Earth."

Introduction: Global Disasters—Local Consequences

Each year weather and climate related natural hazards cause thousands of fatalities and tens of billions of dollars in economic losses worldwide. Hurricanes, typhoons, and mid-latitude storms often cause significant loss of property and life. In 1970, a particularly intense tropical cyclone killed at least 300,000 people in Bangladesh. In 1992, Hurricane Andrew caused 26 deaths and property losses of approximately \$26.5 billion. In the wake of Hurricane Charley that made landfall near Charlotte Harbor Florida on August 13, 2004, emergency management officials and damage assessors have directly linked at least 16 deaths to the storm and estimate property losses of \$7 billion to \$8 billion in insured damage. Statistics

compiled from insurance companies from 1950-1999 show that major natural catastrophes across the globe caused economic losses of nearly \$1 trillion.

At the other extreme, extended periods of drought can be equally devastating. In 1988, dry conditions in the Midwest caused an estimated \$40 billion in crop damage. Current drought conditions in the southwest United States are seriously depleting water resources in the Colorado and Rio Grande River basins, impacting agriculture as well as interstate and international relations. On a broader front, severe drought, inadequate harvests, and civil war in Sudan are putting hundreds of thousands of people at risk of starvation. While these geographically separate conditions affect people locally, worldwide conditions may be related globally to the combined effects of climate change and El Niño and La Niña events.

Environmental observing systems that support better warnings and preparedness can reduce the loss of life and property due to severe storms or drought.

Global Environmental Monitoring

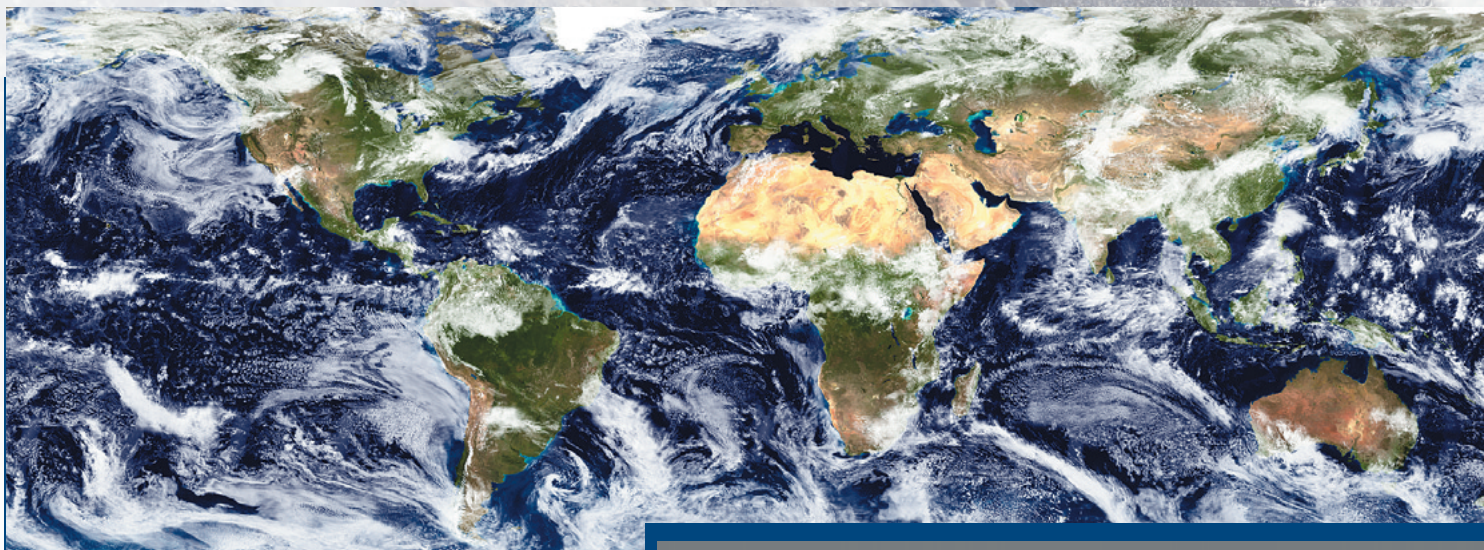
In situ ("in place") observing systems are effective for local and regional monitoring and for certain measurements for which remote sensing techniques are not well suited. However, the global expanse and often remote locations of natural hazards and climate change effects require observing platforms that can provide continuous global coverage.

Operational and research polar-orbiting satellites, along with geostationary satellites, provide cost-effective, continuous global coverage of critical environmental information, such as storms, pollutants,



Employees of Beachcomber Liquors in Port Charlotte, Fla., look at the damage caused by Hurricane Charley as it hit land Friday, Aug. 13, 2004. A U-Haul truck sits in the middle of the store. Hurricane Charley insured losses make this hurricane the second costliest hurricane in US history behind the all-time record holder to date, Hurricane Andrew. Both storms made landfall in Florida. Image courtesy: AP/Wide World Photos

The Backbone of the Global Earth Observation System of Systems



The image above shows the global coverage that NPOESS will provide. This type of coverage is critical to provide an accurate environmental picture of current conditions as input to global, regional and local Numerical Weather Prediction (NWP) models. Data from NPOESS will be updated every four hours or less on a global basis.

The image (right) shows that while the approximate view or "footprint" of the GOES satellites is less than NPOESS coverage, the focus of GOES is to provide rapid updates for the detection of severe weather over North and South America. Updates will come as frequently as every minute without ever losing sight of the rest of the coverage area beginning with GOES-R.

Both images processed by NASA, GSFC Earth Observatory



ocean surface temperatures, precipitation, soil moisture, snow and ice cover, and vegetation health. Dr. Richard A. Anthes, President of the University Corporation for Atmospheric Research (UCAR), considers satellite observations to be the "backbone of an Integrated Earth Observation System." Later this decade, NPOESS will take its place as a series of Earth observation platforms.

With NPOESS satellites in three orbits, equally-spaced in time, most locations on Earth will be imaged and

profiled every four hours or less to provide real-time data, products, and information on a wide variety of parameters, such as: ocean surface temperatures and winds; ocean color; land surface temperatures; terrestrial vegetation, land cover characteristics, and change; soil moisture; atmospheric temperature and humidity; snow cover; Arctic ice packs; and Antarctic ice shelves. These sustained measurements will assist in essential tasks, such as: improving weather forecasts, assessing disasters,

monitoring crops and climate, managing marine resources, and determining environmental change.

Polar-orbiting and geostationary satellite data (GOES) already comprise over 99 percent of the data used in numerical weather prediction (NWP) models (National Centers for Environmental Prediction [NCEP]). NPOESS and GOES-R (Aug-Sept issue) will begin to build the Global Earth Observation System as envisioned by Vice Admiral Conrad C. Lautenbacher, Ph.D., the Undersecretary of Commerce



Tropical Storm Dennis-powered surf left these beach homes standing in water in the community of Rodanthe, NC, on Cape Hatteras National Seashore on September 1, 1999. The house in the middle had been on the oceanfront with a 30-foot beach in front of it. The house on the left had been the second house back from the beach. Protecting, restoring, and managing the use of coastal and ocean resources is a priority for NOAA. Image courtesy: AP/Wide World Photos

for Oceans and Atmosphere and NOAA Administrator, and the representatives from 49 other countries who have agreed to participate in the project. According to VADM Lautenbacher, a global network of observing systems consisting of satellites, aircraft, and other ground- and ocean-based platforms will allow scientists to take "regular full-body scans of the Earth."

These "Earth scans" will provide critical input to numerical weather prediction models. In addition, these scans will provide excellent input to those who predict energy needs months in advance, anticipate soil moisture conditions, and rainfall to help farmers decide what crops to plant and where, to monitor forest fires and issue timely warnings of poor air quality and to anticipate outbreaks of environment-related diseases. It is expected that the return on federal government investments in NPOESS and

GOES-R will be enormous and continue to benefit the nation and international community for decades to come.

Data Management

To meet the challenges of archiving and distributing data from the next generation of environmental satellite systems, NOAA is developing the Comprehensive Large Array-data Stewardship System (CLASS). CLASS will enhance NOAA's capabilities to provide environmental data and information archive and access services both nationally and internationally through effective application of modern, adaptable data storage and distribution technologies. CLASS will be focused on efficient archival of vast quantities of satellite and *in situ* observations, permanent and secure storage, and rapid, cost-effective access to the data. It is anticipated that these goals will be

achieved through increased data storage capacity; improved computer power; use of commercially available, modular hardware and software; enhanced communications capabilities; and improved access through the World Wide Web using enhanced database management tools for search, browse, subset, and order functions.

NOAA and NASA are collaborating so lessons learned can be applied from NASA's past work designing the EOSDIS data system, which primarily serves the science research community. NOAA's challenge is to better serve a large number of growing user communities with operational and research needs.

Ocean Remote Sensing

For the 71 percent of the Earth covered by water, space-based remote sensing provides the only means of obtaining synoptic views of the world's oceans and their surface processes at high spatial resolution over time periods ranging from hours and days to weeks and years.

Ocean observations comprise approximately one-fourth of the 55 requirements for geophysical measurements that will be made by NPOESS sensors. These requirements were established based primarily on existing capabilities and current uses of remote sensing data for applications such as maritime weather warnings, sea ice mapping, ship routing, monitoring of biological productivity zones, harmful algal bloom detection, fisheries management, and climate change analysis. However, many ocean observations from NPOESS and other observing systems will be used to protect, restore, and manage the use of coastal and ocean resources. Users also projected needs for higher resolution satellite data to support operations in coastal and open ocean regions.

Although NPOESS will carry only one instrument designed specifically for ocean observations (*i.e.*, a Radar Altimeter), ocean requirements have directly and substantially "driven" the design and acquisition for the VIIRS and CMIS instruments. With these instruments, NPOESS will deliver higher resolution (spatial and temporal) and more accurate measurements of: sea surface temperature (SST), ocean surface wind

vectors/stress, ocean color, suspended matter, and derived parameters, such as harmful algal blooms, sea ice (edge motion, age, surface temperature, thickness); oceanic heat flux, significant wave height, and sea surface topography. Coastal change will also be an important product from NPOESS as more and more people move to the coastline. Barrier islands move and change, they are dynamic systems that can be monitored from space.

Natural Hazards Monitoring


New sensors are yielding valuable information for the early detection and tracking of developing tropical depressions that often grow into tropical storms and hurricanes. Recent studies by scientists at NOAA's Atlantic Oceanographic and Meteorological (AOML) Laboratory have demonstrated that in some cases the closed circulation in surface winds of a developing tropical depression can be detected in observations of ocean surface wind speed and direction from the SeaWinds scatterometer on NASA's QuikSCAT satellite, prior to seeing cloud swirls in the more traditional visible and infrared satellite imagery. According to Dr. Kristina Katsaros, former Director of AOML, "with more precise input about ocean surface wind speed [and direction], models [will] have more precise information that [may] lead to more accurate predictions of a hurricane's evolution and course." The CMIS instrument on NPOESS will provide the operational capability for observing ocean surface wind speed and direction that will be an important addition to the other tools available to the tropical cyclone forecasting community. Data from CMIS will help improve detection and tracking of developing tropical cyclones in their earliest stages, far from land and surface ship observations where satellites provide the primary source of information on these storms. Near hurricane landfall, precipitation, and soil moisture measurements from CMIS, may also yield critical information for emergency managers in areas susceptible to flooding and mudslides.

While forecasts of hurricane landfall and intensity have improved over the

years, there is room for improvement. Data from the atmospheric sounders (ATMS and CrIS) on NPP and NPOESS will be used to generate vertical cross-sections through hurricanes to derive quantitative information on the warm core and intensity of storms. And, multiple sensors on NPOESS (i.e., VIIRS, CMIS, ATMS, and CrIS) will allow forecasters to more accurately diagnose hurricane intensity and thereby improve numerical model predictions for hurricane tracks, landfall, and intensity.

From land to sea, to wind, rain and drought, improved global monitoring of the Earth will benefit the world's people and provide valuable information about our dynamic and changing environment. This added knowledge from NPOESS and other future satellite systems combined should help to lessen the impact of those changes. NPOESS will be an important step in making that a reality.

Higher (spatial, temporal, and spectral) resolution and more accurate sounding data from instruments on

NPOESS, with greater aerial coverage, will also provide the necessary increase in data resolution in order to support continuing advances in numerical weather prediction models to improve short- to medium-range weather forecasts. We will dive in further and explore just how NPOESS will contribute to improved numerical weather prediction in our next article. 

About the Authors:

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The National Hurricane Center currently issues hurricane track and intensity forecasts out to 5 days. The fourth and fifth days have a heightened degree of uncertainty, as do all forecasts of hurricane track and intensity. It is anticipated that more data from NPOESS will aid NHC forecasters to narrow the stretch of coastline that is evacuated which would save millions of dollars. Pictured here is the 5 a.m. NHC forecast for Hurricane Frances issued on September 3, 2004.